Photosynthesis

Photosynthesis is the process by which plants and other producers known as autotrophs convert the energy of sunlight into the energy stored in organic molecules like glucose. Many biologists consider photosynthesis to be the most important biochemical process occurring on earth. The process basically makes the food for all organisms on earth.

1. Energy and Life
2. Autotrophs make the food for the world.
3. The autotrophs of the world can be either eukaryotic or prokaryotic.
4. Photosynthetic eukaryotes are the green plants and certain protistans like algae. These are the organisms that use the sun as a source of energy.
5. Chemosynthetic prokaryotes are bacteria that usually live in extreme conditions like deep ocean vents, hot springs or hot geysers just to name a few. These prokaryotes make food from chemical oxidation of materials like sulfur compounds and methane gas.
6. Ten percent of the earth’s species are autotrophs.
7. Yearly, autotrophs produce 1.4 x 1014 kg of sugar that is enough to fill boxcars from the earth to the moon and back 50x.
8. Heterotrophs are the organisms that rely upon the autotrophs or other

heterotrophs as sources of energy.

1. The Discovery of Photosynthesis
2. Many scientists have contributed to understanding how plants carry out photosynthesis. Early research focused on the overall process. The scientists listed below did extensive experimentation to help reveal the process of photosynthesis.
3. Jan Van Helmont in 1643 stated that plants gain mass from water intake.
4. Joseph Priestley in 1771 discovered plants release a chemical that keeps a candle burning.
5. Jan Ingenhousz in 1779 discovered plants need sunlight to produce oxygen.
6. Later researchers investigated the detailed chemical pathways involved

in photosynthesis. The following scientists are accredited with helping unravel the intricate chemical pathways involved in photosynthesis.

1. Julius Mayer in 1845 proposed that plants convert light energy into

chemical energy.

1. Samuel Ruben and Martin Kamen in 1941 made use of isotopes to prove that the oxygen that is released comes from the water.
2. Melvin Calvin in 1948 traced the pathway that carbon follows to make glucose. The light-independent reactions are actually known as the Calvin cycle.
3. Rudolph Marcus in 1992 won the Nobel Prize in chemistry for describing the path that the electron takes while traveling down the electron transport chain.
4. Generalized Photosynthesis Equation
5. The word equation reads:

“6 molecules water plus 6 molecules carbon dioxide yields

one molecule glucose plus six molecules oxygen”

1. The chemical equation reads:

6 CO2 + 6H2O -> C6H12O6 +6O2

1. Equation Analysis
2. The reactants or starting materials are water and carbon dioxide.
3. The materials produced in the reaction are known as products. The products of photosynthesis are glucose and oxygen. Actually, oxygen is considered to be a waste product. The “real” job of the producer is to make food.
4. Other Requirements of Photosynthesis
5. Sunlight is the form of energy that is absorbed by the phototrophs to start the process of photosynthesis. Green plants absorb approximately 1% of the sunlight that reaches the surface of the earth daily.
6. The green pigment chlorophyll is responsible for capturing the light for photosynthesis. Chlorophyll consists of two pigments.
7. Chlorophyll a absorbs light in the blue-violet and red regions of the visible spectrum Chlorophyll a is blue-green in color and the main pigment of photosynthesis. Its formula is C55H72O5N4Mg
8. Chlorophyll b absorbs light in the blue and red regions of the visible spectrum. Chlorophyll b helps the chlorophyll a and is considered to be an accessory pigment. The chlorophyll b is yellowish green in color and its formula is C55H70O6N4Mg.
9. Other pigments that can help the chlorophyll absorb light if they are

present in the plant are carotene, xanthophyll and tannin.

1. Site of the Reactions

A. Chloroplasts are the organelles that carry out photosynthesis in most autotrophs. The prokaryotic cells do not have chloroplasts. They carry out photosynthesis in their cell membrane.

1. Chloroplast Structure

a. The chloroplast is surrounded by two membranes. The inner

membrane is folded into many layers which fuse in certain

areas known as thylakoids. A good description of a thylakioid

is a disc like structure containing chlorophyll.

b. Stroma is a gel-like matrix that surrounds the thylakoid.

c. Grana are stacks of thylakoids.

d. Photosystems are clusters of chlorophyll molecules and other

pigments within the grana. Photosystems are described as

“light collecting” units.

1. The term chloroplast is derived from chloros meaning “green” and

plast meaning” form” or ”entity”.

1. Two Reactions of Photosynthesis
2. Light Dependent Reaction
3. In the Light Reactions, light strikes chlorophyll a in such a way to excite electrons to a higher energy state. In a series of reactions the energy is converted (along an electron transport chain) into ATP and NADPH. Water is split in the process(photolysis), releasing oxygen as a by-product of the reaction.
4. Light Reactions require light and take place in the thylakoid membranes of the chloroplast.
5. Calvin Cycle (Dark Reaction, Carbon Fixation, Light Independent Reaction)
6. The Calvin cycle does not need light to carry out the reactions, but the Calvin cycle needs the energy carriers produced in the light reaction to function.
7. Carbon dioxide is the main raw material required in the dark reaction. The carbon dioxide is captured and modified with the addition of hydrogen to form carbohydrates. The incorporation of carbon dioxide into organic compounds is known as carbon fixation.

The energy to accomplish the tasks of the Calvin cycle are provided by the energy carriers ATP and NADPH that are sent over from the light reaction.

1. The Calvin cycle takes place in the stroma of the chloroplast.
2. The Link Between Inorganic and Organic
3. Photosynthesis is a bridge between the inorganic and the organic.
4. The raw materials of photosynthesis are inorganic while the complex carbohydrate produced in the reaction are organic.